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CODE OF PRACTICE FOR HARD CHROMIUM PLATING ON IRON AND STEEL (FOR GENERAL ENGINEERING PURPOSES)

(First Revision)

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Indian Standard

CODE OF PRACTICE FOR HARD CHROMIUM PLATING ON IRON AND STEEL (FOR GENERAL ENGINEERING PURPOSES)

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 30 November 1981, after the draft finalized by the Metallic Finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Hard chromium plating, commonly known as chromium, applied for engineering purposes, is referred to as 'Hard chromium' to distinguish it from deposits used for decorative application. Hard chromium is usually applied directly to the base metal without any precoating. Hard chromium plating under suitable conditions produces a beautiful hard metallic coating, slightly bluish in tint. The surface takes a high polish which is retained to a remarkable degree under many conditions of exposure.

0.3 This code covers plating of hard chromium on steels intended for prolonging the life of all types of steel parts subjected to wear, abrasion, heat, corrosion, etc, to restore dimensions of undersized parts. Stress relieving is not necessary on steels of hardness less than 40 Rockwell *C*. For steels of hardness above 40 Rockwell *C*, stress relieving should be carried out before deposition. Hard chromium plating is not recommended on steels of hardness greater than 62 Rockwell *C*.

0.4 This standard was earlier published in 1962. In this revision modifications have been made with the intention of guiding the electroplater to obtain a hard chromium plating of quality satisfying the requirements of IS : 1337-1980*.

1. SCOPE

1.1 This code covers recommended practices for electro deposition of hard chromium plating on steels.

*Electroplated coatings of hard chromium on iron and steel for engineering purposes (*second revision*).

2. HEAT TREATMENT OF STEEL PARTS PRIOR TO PLATING

2.1 Parts which have been hardened and tempered to a tensile strength not exceeding 1 000 MPa (N/mm^2) and parts which have been nitrided, do not normally need heat treatment.

2.2 Heat treatment is necessary only in the case of hardened steels. If stress relieving is not carried out before plating, flaking of the plating may occur or even worse, the cracks caused by hardening stresses in conjunction with the gas evolved during plating may cause failure of the steel parts during service. For steels of hardness above 40 Rockwell *C*, stress relieving should be carried out before chromium plating in oil at 150°C for half an hour, although this should be taken only as a guide, as time and temperature naturally depend on the size of the job, which may be maximum up to 3 h.

NOTE — In the case of carburized parts, the surface should be shot-blasted.

3. METAL SURFACE PREPARATION

3.1 Parts to be plated should be cleaned and freed from grease and any foreign matter either by solvent degreasing or immersion in hot alkaline solution.

3.2 Parts covered with scale or an oxide coating should be prepared for plating by reverse current etching or pickling in inhibited sulphuric acid followed by sand blasting or vapour blasting, or scouring with fine pumice powder.

3.3 Polishing of parts should be done progressively, starting with coarse abrasives and ending with very fine lapping compounds. Parts requiring a high finish should be buffed with cloth mop using suitable buffing compounds.

3.4 In polishing and buffing, special care should be taken not to damage the contour, sharp edges and corners of the parts. Proper masks and guards should be used.

3.5 Magnetized articles should be demagnetized by reversing the procedure of magnetizing.

4. STOP-OFFS

4.1 During plating, surfaces that are not to be plated are protected. As a preliminary, all articles should be degreased, rinsed and dried. The areas on which chromium plating is not required are masked with lacquers, lead sheet, foil and wire tapes of several kinds as stop-offs. They vary from adhesive tapes backed with lead foil to tapes made of PVC and other plastics.

5. JIGS AND ANODES

5.1 Special care should be taken in the construction of jigs used in hard chromium plating and several designs should be tested before deciding on the right design.

5.1.1 Jigs should preferably be constructed of hard-drawn copper. Brass or steel may also be used.

5.1.2 Conductors and jigs should be of adequate cross-section to carry the current without becoming hot.

5.1.3 Auxiliary anodes should be used to ensure uniform plating in recessed or low current density areas. The anode material may be pure lead or preferably a suitable alloy of lead. Reference may be made to IS : 2606-1979*.

5.1.4 Jigs should be coated with a suitable compound for insulation.

5.1.5 Sharp corners, edges and other excess current density areas should be protected by 'robbers' which consist of un-insulated portion of the jig to divert the current to itself from areas which are likely to receive deposits thicker than the average.

5.1.6 Anodes should conform, as closely as possible, to the cathode contour for uniform deposition.

5.1.7 Jigs and parts should be so designed and arranged as to allow free passage of gases evolved during plating and avoid unsatisfactory deposition due to entrapped gases.

6. CLEANING AND ETCHING

6.1 The parts are usually scoured with pumice powder using a nylon hand scouring brush. After scrubbing, the parts are placed in suitable alkaline electrolytic cleaner for 3-5 min before rinsing and transferring to the sulphuric acid etch.

6.2 The anodic etching may be carried out in 30 percent (m/v) sulphuric acid solution for 30 s to 1 min at 10 to 50 A/dm^2 in the case of mild steels and at 22 A/dm^2 in the case of stainless steels and cast iron. This is followed by a thorough rinsing.

NOTE — Anodic etching may also be carried out in a separate chromic acid solution. Use of the plating solution for this purpose leads to contamination with dissolved iron.

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*Specification for alloy lead anodes for chromium plating (*first revision*).

6.3 After rinsing in warm water at 48 to 57°C for 30 to 60 s, the parts should be immersed in chromic acid etching bath having the same composition as the plating bath at a temperature of 49 to 57°C. Before applying the current, the parts should be immersed in the bath for 1 min. Then the parts should be made anodic for 30 s to 1 min using a current density of 15 to 63 A/dm².

6.4 The parts may now be considered to be ready for hard chromium plating.

7. PLATING

7.1 Composition of the Conventional Bath — The following electrolytic composition is recommended:

Chromic acid	250 g/litre
Sulphuric acid	2·5 g/litre, that is, 100 : 1 ratio

7.1.1 The composition of conventional chromic acid baths catalyzed by sulphate may vary rather widely, provided the ratio by weight of chromic acid to sulphate is within the range 80-120 : 1. Throwing power or distribution of plate is optimum at ratios between 90 to 1 and 100 to 1.

7.1.2 *Analysis and Control of Solution* — The chromic and sulphate contents of the bath should be analysed at regular intervals and the ratio maintained within specified limits. Complete analysis for trivalent chromium, iron, etc, should also be carried out at regular intervals. Total of trivalent chromium and iron oxide in the bath should not normally exceed 10 g/litre.

7.2 Operating Conditions

7.2.1 Current density and temperature of hard chromium plating solutions (*see* 7.1) to give maximum hardness are indicated below:

Average Thickness/h µm	*Solution (250g/litre) at Temperature* °C	*Cathode Current Density* A/dm²
7·5	48-50	22
13	50-54	32
17·5	50-55	48
25	52-56	54
42·5	53-57	108

7.2.2 Plating should be continuous from start to finish, as prolonged interruption of the current may result in a laminated deposit. Following a break in current supply, the articles should be re-etched in chrome solution for about 10 s before deposition is resumed.

7.2.3 In view of the fact that the hardness of the deposit is largely governed by the plating conditions, it is most important that both the temperature and current density are maintained within the specified limits. A bright lustrous deposit usually denotes satisfactory hardness, but a 'milky' appearance often associated with a low rate of deposition indicates that the coating is comparatively soft.

7.2.4 After removing the articles from the depositing vat, they are passed into the drag-out tank, where they receive a first swill to remove most of the chrome solution. They are then rinsed thoroughly in clean cold water followed by hot swill, end neutralized in sodium bisulphite and are finally dried by means of hot sand, stove, or hot sawdust.

NOTE — If for unavoidable reasons, plating is interrupted for more than 5 min, the part should be anodically treated for 2 to 5 min in a chromium stripping solution at a temperature of 46 to 57°C followed by rinsing in water and anodic etching in chromic acid etching bath for 30 to 60 s using 15 to 75 A/dm² at a temperature of 48 to 57°C before returning to the plating bath. In some cases, it may be necessary to strip off the old chromium deposit and to start a fresh. A recommended procedure for stripping off the chromium deposit is given in Appendix A.

7.2.5 The parts should be disassembled from the jigs and fixtures; waxes or lacquers should be removed and the parts cleaned.

8. SURFACE PREPARATION AFTER PLATING

8.1 Parts requiring highly polished surfaces should be polished with felt bobs, buffs or brushes as required, depending on the shape of the part. A fast cutting stainless steel buffing compound or green chrome rouge may be used. Dry aluminium oxide powder may be used for a bright finish. The parts should then be cleaned with a solvent before inspection.

9. HEAT TREATMENT AFTER PLATING

9.1 When dealing with surface-hardened or high tensile steel components of narrow cross-section, it may be necessary to stove or heat treat such parts before grinding, so as to obviate any danger of their cracking when put into service.

9.2 Where some reduction in hardness is permissible in the hard chromium deposit, the components may be heat treated at about 450°C for 1 h, and then air cooled.

9.3 In other cases, heat treatment after plating may be omitted. If, however, there is a possibility of serious hydrogen embrittlement and a reduction in the hardness of the deposit would not be acceptable, then heat treatment at a temperature of 200 ± 10°C for 2 to 6 h may be applied. Heat treatment at this lower temperature may result in a lowering of the fatigue strength of the components, and shall for this reason be, where possible, avoided. With very high tensile steel, the requirements of the appropriate specification shall be followed.

9.4 Where grinding is to be carried out for chromium plating, grinding should be done after heat treatment if it is necessary. A recommended practice for grinding is given in Appendix B.

APPENDIX A

(*Clause* 7.2.4, *Note*)

RECOMMENDED PRACTICE FOR STRIPPING OFF CHROMIUM DEPOSIT

A-0. The removal of chromium deposits as a means of salvaging in correctly plated parts.

A-1. METHODS OF STRIPPING

A-1.1 Sodium Hydroxide (40 to 200 g/litre) — Anodic treatment at 3 to 8 A/dm^2 with bath temperature 20 to 70°C.

A-1.2 Anhydrous Sodium Carbonate (40 to 55 g/litre) — Anodic treatment at 2·3 to 5·4 A/dm^2 with bath temperature up to 65°C to reduce the possibility of pitting alloy steel. Use of a low current density and high temperature reduces the possibility of pitting of alloy steel.

A-1.3 Sodium Hydroxide (45 to 50 g/litre) — Sodium carbonate, 30 to 35 g/litre, anodic treatment at 5 A/dm^2.

NOTE — Removal of chromium deposit is best achieved by anodic treatment in an alkaline solution, as use of an acid solution will lead to occlusion of hydrogen and hence hydrogen embrittlement, especially in the case of high tensile strength steels.

A-1.4 Concentrated hydrochloric acid at room temperature.

A-1.5 Hydrochloric acid (12 percent) by volume; bath temperature 48 to 52°C.

APPENDIX B

(*Clause* 9.4)

RECOMMENDED PRACTICE FOR GRINDING OF HARD CHROMIUM PLATED DEPOSITS

B-1. GENERAL PRECAUTIONS

B-1.1 Though chromium is not the easiest of metals to grind, it is certainly not the most difficult. When ground, the metal has a bluish white spark, and the overgrowth soon cuts ridges into the wheel. Occluded hydrogen in the chromium deposit expands due to the heat generated during grinding and causes the chromium to crack all over the surface.

B-1.2 In the grinding of heavy deposits for the removal of sizeable amount of deposited chromium metal to attain the required dimensions or surface finish, the most important requisites for successful results are:

a) A soft grinding wheel,

b) Sufficient amount of coolant,

c) A light cut,

d) Correct peripheral speed,

e) Freedom from vibration, and

f) Frequent wheel dressing.

Because chromium is hard and brittle, a soft grinding wheel is essential. A hard wheel forms a glazed surface, which results in temperature rise that causes the chromium to crack.

B-2. SELECTION OF GRINDING WHEEL

B-2.1 A suitable grinding wheel shall be selected in accordance with the recommendations given in IS : 1249-1972*.

Good performance may be obtained with an aluminium oxide resin bonded wheel, the abrasive material size being approximately 60 grit.

B-3. SPEED OF GRINDING WHEEL

B-3.1 The speed of the grinding wheel is usually maintained at 30 m/s.

*Recommendations for selection of grinding wheels (*first revision*).

B-4. SPEED OF COMPONENTS

B-4.1 The surface speed of the component being ground should be in the range of 0·15 to 0·3 m/s and the traverse 1·8 to 2 m/min.

B-5. FLOW OF COOLANT

B-5.1 The supply of the coolant should be continuous and copious to avoid local heating with consequent stressing and cracking of the deposit.

Soluble oil, diluted to 20 : 1, is quite satisfactory for grinding of hard chromium deposits.

B-6. DRESSING

B-6.1 The grinding wheel should be frequently dressed with a diamond, in order to ensure that cutting takes place without over-heating.

B-7. DEPTH OF CUT

B-7.1 The stock removal should be in the region of 10-13 μm deep, but in special cases it may have to be reduced to as little as 5 μm.

BUREAU OF INDIAN STANDARDS

Headquarters:
Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002
Telephones: 323 0131, 323 3375, 323 9402 **Fax** :+ 91 11 3234062, 3239399, 3239382
E - mail : bisind @ del 2.vsnl.net.in **Internet** : http://wwwdel.vsnl.net.in/bis.org

Central Laboratory :	***Telephone***
Plot No. 20/9, Site IV, Sahibabad Industrial Area, Sahibabad 201010	91-77 00 32
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